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Assessing factors that may predispose Minnesota farms to wolf depredations on cattle

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Abstract Wolf (*Canis lupus*) depredations on livestock cause considerable conflict and expense in Minnesota. Furthermore, claims are made that such depredations are fostered by the type of animal husbandry practiced. Thus, we tried to detect factors that might predispose farms in Minnesota to wolf depredations. We compared results of interviews with 41 cattle farmers experiencing chronic cattle losses to wolves (chronic farms) with results from 41 nearby "matched" farms with no wolf losses to determine farm characteristics or husbandry practices that differed and that therefore might have affected wolf depredations. We also used a Geographic Information System (GIS) to detect any habitat differences between the 2 types of farms. We found no differences between chronic and matched farms in the 11 farm characteristics and management practices that we surveyed, except that farms with chronic losses were larger, had more cattle, and had herds farther from human dwellings. Habitat types were the same around farms with and without losses. The role of proper carcass disposal as a possible factor predisposing farms to wolf depredations remains unclear.

Key words animal husbandry, *Canis lupus,* cattle, depredations, habitat, livestock, predation, wolves

Wolf (*Canis lupus*) depredations on livestock are a serious concern to Minnesota farmers, resource managers, agricultural officials, environmentalists, and state legislators. The wolf in Minnesota is currently on the federal endangered species list in the "threatened" category. However, because wolf numbers there have exceeded recovery levels (B. Berg and S. Benson, unpublished report, 1999), the federal government will soon propose removing the wolf in Minnesota from the endangered species list. Minnesota will then be responsible for wolf management, and continued control of wolves preying on livestock will be one of the greatest management needs (Mech 1998).

Although the total proportion of farms in wolf range that suffer verified wolf depredations is only about 1% per year (W. J. Paul, unpublished report, 1998), several factors must be considered to provide a more complete understanding of the importance of wolf depredations: 1) because it is difficult to verify wolf depredations, far more livestock may be lost to wolves than are verified (Roy and Dorrance 1976, Fritts 1982); 2) to farmers who do suffer damage, the loss is real and significant economically, even though partially offset by state compensation payments for verified losses; 3) over a period of years, livestock from hundreds of farms have been preyed upon; 4) number of farms sustaining such damage is increasing at an accelerating rate (Mech 1998); 5) wolf range is currently

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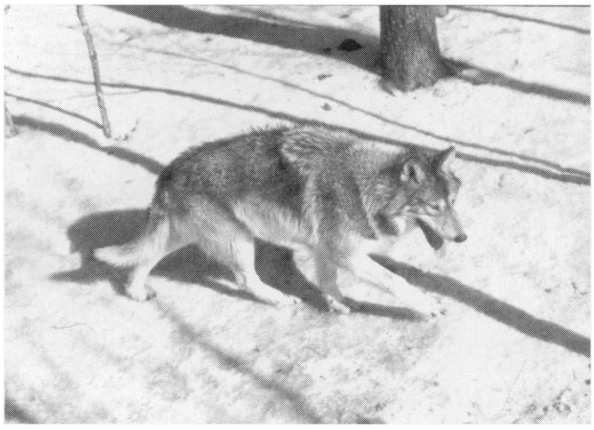


The wolf has reached federal recovery levels in Minnesota, Wisconsin, and Michigan.

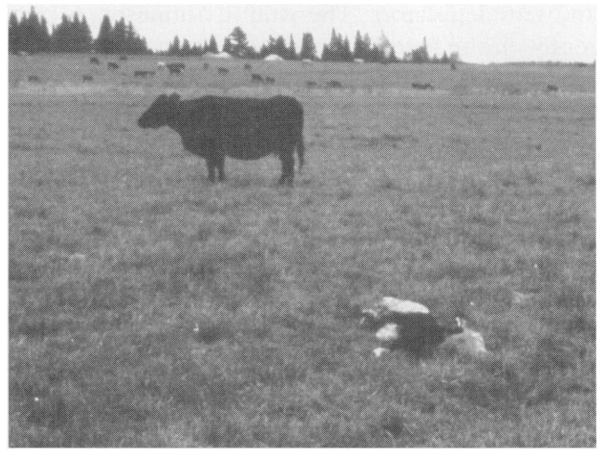
expanding into some of Minnesota's greatest densities of livestock (Minnesota Agriculture Statistics 1997); and 6) the wolf population has reached a level at which standard hunting and trapping techniques may be unable to prevent increases (Mech 1998).

Since 1978, when the wolf in Minnesota was downlisted from federally endangered to threatened, the United States Fish and Wildlife Service and then the United States Department of Agriculture's Wildlife Services (WS) have conducted lethal control of wolves around farms where depredations have been verified (Fritts 1982, Fritts et al. 1992), a program costing $300,000 in 1998. In addition, the Minnesota Department of Agriculture currently pays about $67,000/year in compensation for livestock confirmed lost to wolves. Conservative projections of these 2 costs exceed $400,000/year for the next few years (Mech 1998).

Concurrent with the increase in wolves and wolf range, the number of wolves killed for depredation control has increased dramatically from 6 in 1979 to 216 in 1997. Projections show that a conservative estimate of the number of wolves that may need to be killed for depredation control by 2005 might exceed 400/year (Mech 1998), a serious concern to wolf advocates and environmentalists (Anderson 1999).

There has long been a belief that wolves prey on livestock because of poor husbandry practices by farmers. This could be a misinterpretation of the claim that "many instances of wolf depredation on livestock in Minnesota seem to be related to animal husbandry practices" (Fritts 1982:7), a statement which implicates poor husbandry practices but does not place sole blame on them for wolf depredations. Acknowledging that "data collection on these issues was not extended beyond that taken for the earlier report," Fritts et al. (1992:14) indicated that "any further conclusions are subjective" and that "research is needed to. . . determine the causes of the onset of stock-killing behavior." Fritts (1982) and Fritts et al. (1992) identified 3 factors as potentially predisposing livestock to wolf depredations: 1) pasturing in wooded-brushy areas, 2) calving in wooded-brushy areas or in remote open range rather than in or near barns, and 3) improper disposal of carcasses, which can attract carnivores; this practice could affect the farm involved or even neighboring farms. Similarly, livestock depredations in western Canada seem to be related to the forest-agricultural edge (Gunson 1983, Bjorge and Gunson 1985), livestock production in forested areas (Gunson 1983), and improper carcass disposal (Tompa 1983). Gunson (1983) also stated that livestock depredations at these edges are influenced by the number of livestock present, animal husbandry practices, and potentially relative abundance of natural prey.

We sought to assess the role of suspected major factors that may predispose cattle to wolf depredations and to attempt to elucidate any unknown factors. We did not intend to examine such basic husbandry practices as maintaining herds in good health and nutrition and taking reasonable care of them.



This study attempted to find animal husbandry or habitat factors that distinguished farms suffering chronic depredations to wolves from those that did not. The calf in foreground was killed by a wolf.

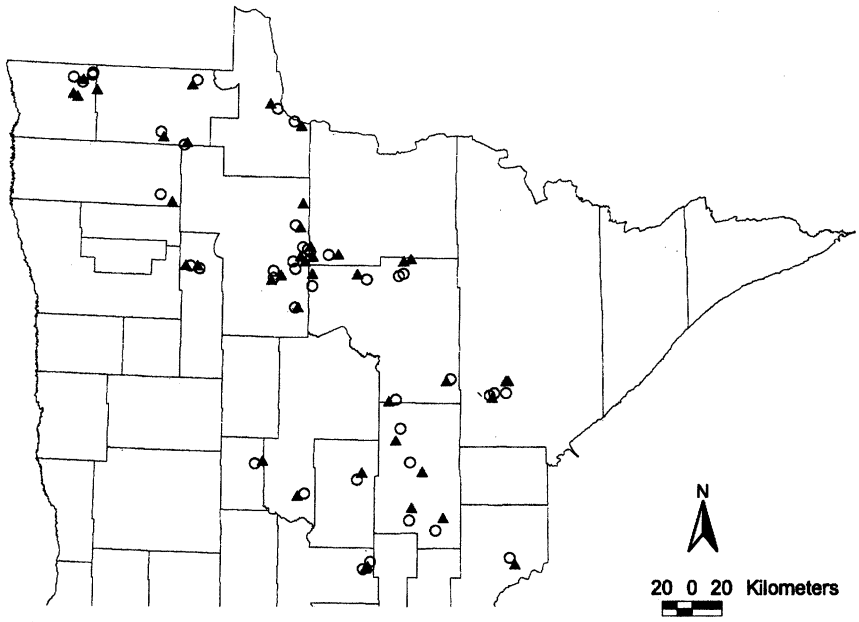


Figure 1. Locations of Minnesota farms suffering chronic depredations by wolves during 1989–1998 and farms not suffering losses, chosen as a matching sample.

Methods

To attempt to identify factors that predispose some cattle farms in Minnesota to wolf depredations, we interviewed farmers who had recurring depredation problems between 1989 and 1998 (chronic farms). We also interviewed neighboring farmers who had no wolf depredations during the same period (matching farms, Figure 1). We hypothesized that if 2 farms were close enough to be within a reasonable range of the same wolves, but one farm had depredation problems and the other did not, there could be discernible differences between the 2 farms that would lend insight into why wolves preyed on livestock at some farms but not others.

We chose to study chronic farms rather than those experiencing only occasional loss because chronic farms are more likely to have some characteristic that predisposes them to depredations. Farms that experience only occasional losses are more apt to be affected by random events, such as the presence of a dispersing wolf passing through the area (Fritts 1982).

To assess which farms suffered chronic losses, we created a database from WS records of all verified wolf depredation complaints from 1989 to 1998. We ranked farms according to number of calendar years when they suffered verified losses. We defined chronic farms as those where WS personnel had verified at least one wolf depredation in each of 3 or more years during the 10-year period (Fritts et al. 1992).

We deemed 51 farms (4 sheep, 4 turkey, and 43 cattle) in 15 counties as chronic during 1989–1998. Because of the low number of sheep and turkey farms and the difficulty of finding a match for them, we considered only cattle farms. We used 41 of 43 cattle farms in the analysis as we were unable to interview owners of one chronic farm and unable to find a match for another. Though all had wolf losses during at least 3 years in 10, the history of depredations on these farms varied considerably. Individual farms experienced up to 18 episodes of depredation during the study and had depredations during 8 years of the 10-year period.

Around each chronic farm, we attempted to locate other farms raising the same type of livestock (beef cattle or dairy cattle) where wolf depredation had not occurred (matching farms). To randomize our matching sample, we chose a cardinal direction from the depredated farm by throw of a die and first searched for matching farms in that direction within 8 km of the chronic farm. The principal method of locating matching farms was driving in the random cardinal direction looking for livestock, pasture areas, and hay storage. WS personnel, county extension agents, cattlemen's associations, and other farmers also were questioned as to the locations of potential matching farms.

If we did not find a farm without claimed wolf losses within 8 km in the initial compass quadrant, we extended the search in other directions, working clockwise from the initial random direction. In some cases, we needed to go up to 15 km from the chronic farm to locate non-problem farms to survey. Several farms were usually surveyed near each chronic problem farm until a suitable matching farm was found.

We avoided using as matching farms those with verified wolf problems that did not reach the level of chronic farms. If an operator claimed to have suffered wolf depredation, even if no losses had been verified in the last 10 years, we rejected that farm as a matching (non-depredated) farm and chose other matching farms.

We visited each of the chronic and matching cattle farms one to 4 times between July 1998 and January 1999 to survey the owner or manager in person. When this could not be done, we conducted telephone interviews ($n = 15$). Interviews covered location and size of the livestock operation, history of livestock raising and depredation problems, farm size, number of cattle, number of years raising cattle, amount of pasture bordered by brush or forests, longest distance of livestock from house, pasture characteristics, calving locations, number of times stock were checked each week, presence of carcass dump, and carcass disposal methods.

Besides the 41 farmers at chronic farms, we interviewed 145 farmers at matching farms and chose 41 matches that fit the criteria stated above. We then summarized the answers to the survey questions that might provide insight into factors predisposing livestock to wolf depredations.

A factor identified as possibly being important in predisposing certain farms to wolf depredations was leaving livestock carcasses where scavengers could use them (Fritts 1982, Fritts et al. 1992). As part of a separate survey involving use of rendering plants for carcass disposal, we requestioned farmers in our sample of matching farms about their carcass disposal methods. We attempted to phone each matching farm during 15 April to 2 May 1999.

The group of chronic farms we surveyed was essentially an entire population rather than a random sample. Therefore, to determine significant differences between measures derived for chronic farms versus measures for our sample of matching farms, we used the following approaches. We considered any average measure of the chronic population to differ significantly from that of the matching sample if the average for the chronic farms fell outside the 95% confidence limits of the average of the matching sample. To compare distributions of characteristics between our 2 types of farms, we used the chi-square test.

We created a GIS coverage of chronic farms and another of matching farms. Using ArcView (Environmental Systems Research Institute, Redlands, California, USA) GIS software, we created zones with radii of 1.6 km and 4.8 km around farms to examine surrounding habitat. We dropped one chronic farm and its match from the analysis of the 4.8-km radius because the radius extended out of Minnesota, where we had no habitat data.

For our habitat analysis we used a coverage assembled by the Minnesota Department of Natural Resources, Grand Rapids, which mapped 8 cover types (urban and rural development, cultivated land, hay-pasture-grassland, brush, forest, water, bog-marsh-fen, and mining). The source data were collected between 1987 and 1996 and were originally captured in 30-m (13 counties) and 90-m (2 counties) cells and then converted into a feature data source.

We then used ArcView to estimate percentage of each habitat type for chronic and matching farms within the 1.6-km and 4.8-km radii. The data for each kind of farm were pooled to give a single set of percentages of habitat for each kind. We hypothesized that if farms with chronic losses were surrounded by some specific cover or land-use type that predisposed them to wolf depredations, then the pooled data should differ from those for the matching farms in proportions of habitat types.

Because of the possible importance of carcass disposal as a predisposing factor and because improper carcass disposal is illegal, we attempted to cross-check reporting about this subject. For chronic farms, we asked WS personnel about their personal knowledge of carcass disposal at these farms and compared their replies with those obtained from direct interviews.

WS personnel had no personal knowledge of conditions on matching farms, however. Thus, as a cross-check for those farms, we compared replies about carcass disposal at matching farms with replies to a similar question asked of the same farms during the special telephone survey about rendering plants.

Results

All but 3 of the 11 farm characteristics and management practices we assessed were similar for chronic and matching farms, with one factor being equivocal (Tables 1-4). The 3 factors that differed were size of farm, number of livestock, and distance of livestock from human dwelling, and these factors were correlated ($r^2 = 0.09$-0.37, $P = 0.001$-0.05). The chronic farms were larger (491 vs. 292±71 ha), had more cattle (158 vs. 82±18), and had herds

Table 1. Mean (±95% confidence limits) values of Minnesota farm characteristics for 41 farms suffering chronic wolf depredations on cattle and 41 nearby matching farms that experienced no such losses, 1989–98.

	Chronic[a]	Match[a]
Farm size (ha)	491	292 ± 71
Number of cattle	158	82 ± 18
Number of years raising cattle	38	35 ± 8
Amount (arc°) of pasture bordered by brush-forest	213	205 ± 38
Longest distance livestock is from house (km)	2.8	1.8 ± 0.5

[a] Chronic farms represented a complete population, except for 2 farms, whereas matching farms were a sample.

farther (mean maximum distance=2.8 km vs. 1.8± 0.5 km) from human dwellings (Table 1).

The equivocal factor was method of carcass disposal. Contrary to expectations, more farms with chronic losses reported properly disposing of carcasses than did matching farms not suffering cattle depredations (Table 5). However, WS personnel indicated that they had observed evidence of at least an intermittent carcass dump on all except 2 of the 41 farms with chronic losses. Number of carcasses that matching farms disposed of varied from 2 to 10/year.

Habitat-land-use characteristics for chronic farms and their matches were similar in all respects that we could measure for the 1.6-km and 4.8-km radii (Table 6). In other words, neither habitat nor land-use proportions within 1.6 or 4.8 km around farms differed between chronic and matched farms.

Table 2. Types of pasture where cattle were located at 41 Minnesota farms suffering chronic wolf depredations on cattle and 41 nearby matching farms experiencing no such losses, 1989–98.

Type of pasture	Total chronic [a]	Total matching [a]
Brushy	0	2
Open	13	14
Wooded	0	0
Open-brushy	4	4
Open-brushy-wooded	11	7
Open-wooded	13	14
Total	41	41

[a] Chronic farms represented a complete population, except for 2 farms, whereas matching farms were a sample. (χ^2_4=2.96, P=0.56).

Table 3. Calving locations for 41 Minnesota farms suffering chronic wolf depredations on cattle and 41 nearby matching farms that experienced no such losses, 1989–98.

Location of calving	Total chronic [a]	Total matching [a]
Barn	3	4
Barnyard	29	25
Barn and barnyard	0	3
Pasture	7	6
Pasture and barn	1	0
Pasture and barnyard	1	1
No calves	0	2
Total	41	41

[a] Chronic farms represented a complete population, except for 2 farms, whereas matching farms were a sample. (χ^2_6=6.52, P=0.37)

Discussion

The only definite and significant differences we found between farms suffering chronic losses to wolves and their nearby matching farms that experienced no losses were a suite of related size characteristics: size of farm, number of cattle, and longest distance of stock from human dwellings. Our findings regarding carcass disposal were unclear.

A number of possibilities may explain why larger farms with more cattle pastured farther from human dwellings suffered more wolf depredations. Larger operations may have had greater exposure to wolf depredations simply because of their size and perhaps because wolves were attracted to larger herds. Maximum distance that stock was pastured from

Table 4. Number of times/week Minnesota farmers checked cattle at 41 farms suffering chronic wolf depredations on cattle and 41 matching farms that experienced no such losses, 1989–98.

Times stock checked	Chronic farms [a]	Matching farms[a]
0	1	0
1	1	3
2	5	5
3	3	1
4	2	6
7	21	20
14	7	4
Almost daily	1	0
More than twice/day	0	2
Total	41	41

[a] Chronic farms represented a complete population, except for 2 farms, whereas matching farms were a sample. (χ^2_8=8.84, P=0.36.)

human dwellings, due to the larger farm size, would not seem to be relevant because wolves often kill stock near houses and buildings. Furthermore, we know of no reason the difference between the 2.8-km mean maximum distance for chronic farms and the 1.1 (±0.5)-km distance for the matching farms would be meaningful to wolves, and the difference between the mean distances of cattle from the houses in the 2 groups would be even less. Larger farms and herds also may have had less human presence. Conceivably, farm size itself was a neutral factor, but some unknown factor related to farm size was causative.

There are several possible explanations for the counter-intuitive and equivocal nature of the findings about carcass disposal. Eighty-five percent of chronic farms reported properly disposing of carcasses, whereas only 56% of matching farms reported proper disposal during the same survey. Conceivably, at least some farms with chronic losses, having been visited so frequently by government personnel and advised to dispose properly of carcasses, actually did so, an interpretation at least partly supported (Fritts et al. 1992).

Other possible explanations are: 1) farmers with chronic losses may be making a sincere effort to alleviate their problem by properly disposing of carcasses; 2) larger operations may have more need for systematic carcass disposal and therefore more efficient methods—for example, preparing a large pit for frequent use; or 3) larger farms may be more likely to own heavy equipment to bury carcasses.

On the other hand, false reporting about livestock carcass disposal also may have been a problem with chronic farms. This interpretation is supported by the disparity between interview results from farmers suffering chronic losses and the recollections of WS personnel. This disparity may be due to the different periods covered by the 2 types of data collection. Our survey covered only 1998, whereas the recollections of WS personnel spanned a decade or more. Perhaps some chronic farms had carcass dumps prior to 1998 but no longer have them. Potentially all these factors were operating.

Although these confounds prevent any firm conclusion, some interesting insights into responses to questions about carcass disposal can be extracted from the matching sample results. Of 18 matching farms that answered the basic survey and the rendering plant survey, 44% replied similarly in both surveys that they burned or buried carcasses or sent them to rendering plants (proper disposal), 28% replied similarly in both surveys that they left carcasses above ground (improper disposal), and 28% replied dissimilarly on the 2 surveys. Thus, 56% of farmers who had not suffered wolf depredations admitted on either or both surveys that they improperly disposed of carcasses. Nevertheless, all

Table 5. Carcass disposal methods for 41 Minnesota farms suffering chronic wolf depredations on cattle and 41 nearby matching farms that experienced no such losses, 1989–98.

Carcass disposal method	Total chronic farms [a]	Total matching farms [a]
Bury	24	13
Burn	3	4
Carcass dump	1	3
Carcass dump and burn	0	1
Rendering plant	3	2
Leave in pasture	2	10
Bury and lime	1	0
Bury and burn	2	3
Leave in pasture and burn	1	0
Leave in pasture and feed to dogs	1	1
Leave in pasture and bury	1	1
Rendering plant and bury	1	1
Rendering plant and feed to dogs	1	0
Rendering plant and pasture	0	1
Unknown	0	1
Total	41	41

[a] Chronic farms represented a complete population, except for 2 farms, whereas matching farms were a sample. ($\chi^2_{14} = 6.15$, $P=0.30$)

Table 6. Percentage of habitat types within circles of 1.6-km and 4.8-km radii around the farms summed for 41 Minnesota farms suffering chronic wolf depredation on cattle and 41 nearby matching farms that experienced no such losses, 1989–98.

	1.6-km radius		4.8-km radius[a]	
Habitat Type	Chronic farms[b]	Matching farms[b]	Chronic farms[b]	Matching farms[b]
Bog-marsh-fen	12	9	17	14
Brushland	10	10	9	9
Cultivated	19	22	15	16
Forested	35	34	43	43
Hay-pasture-grassland	23	22	13	14
Mining	0	0	0	0
Urban-rural development	1	1	1	1
Water	1	1	2	3

[a] Chronic farm without a matching farm not included in analysis.

[b] One chronic farm and its match removed as the 4.8-km buffer extended outside of habitat coverage. Because results were so obviously similar, they were not tested statistically, in keeping with Chatfield (1995) and Cherry (1998).

these farms are within 15.2 km (mean of these 56% farms = 6.2 km, range 1.6–15.2 km) of farms that experienced chronic depredations by wolves. If improper carcass disposal were of prime importance in predisposing farms to wolf depredations, one wonders why matching farms did not suffer such depredations.

One possible explanation is that because matching farms held fewer cattle, they may have sustained fewer general losses and thus had fewer carcasses available. Larger farms generally would have more natural losses and thus might have provided a more reliable food source at carcass dumps, thus attracting wolves more often. This interpretation could even be the explanation for why larger farms with more cattle tended to experience wolf depredations. However, the whole subject of carcass disposal as a factor predisposing cattle to wolf depredations remains open.

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Literature cited

ANDERSON, D. 1999. Sierra Club director opposes wolf restrictions. Star Tribune, 14 March 1999.

BJORGE, R. R. AND J. R. GUNSON. 1985. Evaluation of wolf control to reduce cattle predation in Alberta. Journal of Range Management 38:483–487.

CHATFIELD, W. C. 1995. Problem solving: A statistician's guide. Chapman and Hall, London, United Kingdom.

CHERRY, S. 1998. Statistical tests in publications of The Wildlife Society. Wildlife Society Bulletin 26:947–953.

FRITTS, S. H. 1982. Wolf depredation on livestock in Minnesota. United States Fish and Wildlife Service, Research Report 145.

FRITTS, S. H., W. J. PAUL, L. D. MECH, AND D. P. SCOTT. 1992. Trends and management of wolf-livestock conflicts in Minnesota. United States Fish and Wildlife Service Resource Publication No. 181.

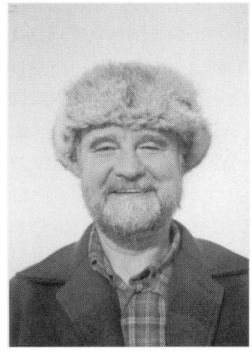
GUNSON, J. R. 1983. Wolf predation on livestock in western Canada. Pages 102–105 *in* L. N. Carbyn, editor. Wolves in Canada and Alaska: their status, biology and management. Canadian Wildlife Service Report 45, Ottawa, Ontario, Canada.

MECH, L. D. 1998. Estimated cost of maintaining a recovered wolf population in agricultural regions of Minnesota. Wildlife Society Bulletin 26:617–622.

MINNESOTA AGRICULTURE STATISTICS. 1997. Minnesota Agriculture Statistics Service, St. Paul, USA.

ROY, L. D., AND M. J. DORRANCE. 1976. Methods of investigating predation of domestic livestock. Alberta Agriculture, Edmonton, Alberta, Canada.

TOMPA, F. S. 1983. Problem wolf management in British Columbia: conflict and program evaluation. Pages 112–119 *in* L. N. Carbyn, editor. Wolves in Canada and Alaska: their status, biology and management. Canadian Wildlife Service Report 45, Ottawa, Ontario, Canada.



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